

REMARKS

Claims 1-4 and 6-8 are presently pending in the application.

The Examiner has again rejected claims 1-8 under 35 U.S.C. §102(e) as being anticipated by or under 35 U.S.C. § 103(a) as being obvious over each of U.S. Patent No. 6,358,648 of Hayashi et al. ("Hayashi") and U.S. Patent No. 6,083,642 of Kato et al. ("Kato"). Applicants respectfully traverse these rejections and the arguments in support thereof for the reasons set forth in the previous Amendments, which Applicants rely upon in full, and for the additional reasons set forth below, and respectfully request reconsideration and withdrawal of the rejections. It is noted that claim 5 was cancelled in the Amendment filed May 25, 2004, so the rejection of this claim is moot.

Rejections Under §§ 102(e) and 103(a) Based on Hayashi and on Kato

The Examiner's arguments in support of his rejections based on Hayashi and on Kato are essentially identical to those in the previous Office Action and will only be summarized here for convenience. Briefly, the Examiner contends that Hayashi teaches all of the attributes of the claimed positive electrode active material either explicitly (such as elemental composition and mean particle size) or inherently. Specifically, the Examiner takes the position that since the positive electrode active materials disclosed by Hayashi and the present application have similar chemistry and manufacturing procedures, properties of the Hayashi material which are not disclosed, such as BET surface area, particle size distribution and full width at half maximum of a particular crystallographic orientation, are inherent. Additionally, the Examiner contends that it would have been obvious to one having ordinary skill in the art at the time of the invention to adjust the pH values or the degree of mixing and stirring of the solution, such that the number of particles having a circularity of not larger than 0.85 accounts for not more than 5% of the total number of particles in the positive electrode active material.

Similarly, the Examiner maintains that Kato also teaches or suggests all of the claimed elements, including a positive electrode material for an alkaline storage battery comprising nickel hydroxide particles and a higher cobalt oxide, in which the NiOH particles have the claimed particle size and surface area. The Examiner takes the position that other properties of the material, such as particle size distribution and full width at half maximum of a particular

crystallographic orientation, are inherent, given that the positive electrode active materials disclosed by Kato and the present application have similar chemistry and manufacturing procedures. The Examiner again contends that it would have been obvious to one having ordinary skill in the art at the time of the invention to adjust the pH values, the degree of mixing, or the heating temperature of the solution, such that the number of particles having a circularity of not larger than 0.85 accounts for not more than 5% of the total number of particles in the positive electrode active material.

Applicants previously argued that neither Hayashi nor Kato describes or controls the temperature of the raw material active solution, and that in order to control the mean particle circularity to not smaller than 0.95 and to limit the number of particles having a circularity of not larger than 0.85 to not more than 5% of the total number of particles, it is necessary to maintain at constant levels the temperature and pH of the reaction vessel and the temperature of the raw material solution supplied to the reaction vessel. The Examiner responds that the claimed novelty is not stated in the independent claim, and further that both Hayashi and Kato have identical pH and mixing (stirring) of the solution as the processing variables in the fabrication of the positive electrode active material. Therefore, the Examiner concludes that it would have been obvious to one having ordinary skill in the art at the time of the invention to adjust the pH and the degree of mixing of the solution to yield nickel hydroxide or nickel oxyhydroxide powders of desired circularity and distribution of circularity.

For all of these reasons, the Examiner still concludes that both Kato and Hayashi anticipate or render obvious all of the pending claims, which Applicants respectfully traverse for the reasons set forth previously and for the additional reasons which follow.

The present invention relates to a positive electrode active material for an alkaline storage battery containing a nickel hydroxide powder and/or a nickel oxyhydroxide powder, in which the positive electrode active material exhibits particular physical properties, and a method of making a positive electrode using such positive electrode active material. The positive electrode active material has a mean particle circularity from 0.95 to 1, and the number of particles having a circularity of not larger than 0.85 accounts for not more than 5% of the total number of particles within the positive electrode active material.

While Hayashi and Kato disclose an active material which is "spherical", neither reference teaches controlling the raw material solution at a constant temperature. When the raw

material solution is not controlled at a constant temperature, as described in the present application, a greater number of particles having various shapes will be produced, including amorphous particles having a rough surface, aggregated particles, particles having a nearly elliptical shape, and particles having a nearly perfect spherical shape, resulting in a considerable variation in particle shape. U.S. Patent No. 6,040,007 of Junichi et al. (previously cited by Applicants in an Information Disclosure Statement) is similar to Hayashi and Kato in that active materials are produced without maintaining a constant temperature of the raw material solution. The resulting variation in the particle shape may be seen from the Figures of the '007 patent (attached), electron micrographs of nickel hydroxide crystals produced according to a method which lacks a constant temperature of the raw material active solution.

While Hayashi and Kato disclose spherical particles, neither teaches measuring the circularity by the precise method of the present invention, which relies on projected images of captured particles (see page 13, line 13 to page 15, line 12 of the specification). Therefore, one skilled in the art would understand that "spherical" as used by Hayashi and Kato should be loosely interpreted to include particles having a perfectly spherical shape, as well as those having a nearly spherical shape, an elliptical shape, etc. Further, since the raw material solution in Hayashi and Kato is not controlled at a constant temperature, particles having various shapes would be expected to be present in the resulting active material, as previously explained, and there would also be expected to be considerable variations in the shape of the active material.

In order to prepare a positive electrode active material having the high circularity and small variation in circularity exhibited by the present invention, it is necessary to vigorously stir the reaction solution in addition to controlling the temperature of the raw material solution, as previously described. It takes at least several days and as long as several weeks to prepare spherical nickel hydroxide. Commercially, production facilities are operated consecutively and the temperatures of raw material solutions vary with changes in ambient temperature during the operating period (e.g., differences between day and night temperatures and seasonal temperature changes throughout a year). Such variations in the temperatures of raw material solutions also affect the production rate and the amount of crystal nuclei produced, which change the physical properties of the resulting powders. Accordingly, even if the temperature of the reaction vessel is controlled, it is still important to control the temperature of the *raw material solution* and is

essential in the Examples of the present application to maintain the raw material solution at a constant temperature.

Upon the addition of the raw material solution to the reaction solution, the following reactions occur successively: crystal nucleation, crystal growth, and the growth of a particle which is an aggregate of crystal nuclei. The shape and size of the crystal nuclei and those of the particle comprising the crystal nuclei are greatly affected by the temperature of the raw material solution and the speed at which the solution is stirred. This is because the crystal nucleation, the speed of crystal growth, and the growth direction of the crystal nuclei vary depending on the temperatures of the raw material solution and the reaction solution, the temperature difference between the raw material solution and the reaction solution, and the stirring speed.

Therefore, by controlling the temperature of the raw material solution, the variation in the shape and the size of the resulting crystal nuclei and particle will be extremely small. Further, it is impossible to produce particles having a circularity of not greater than 0.85 in an amount equal to not greater than 5% of the number of total particles in the active material without controlling the raw material solution at a constant temperature, even if the reaction solution is vigorously stirred.

In contrast, as previously explained, neither Hayashi nor Kato describes or controls the temperature of the raw material active solution, and the raw material solution temperature thus depends solely on ambient temperature, as in Comparative Example 1 of the present application. Therefore, it is reasonable to conclude that the circularity obtained in Hayashi and Kato would be similar to that in Comparative Example 1, not greater than 0.94 with great variation among the particles. Further, since the temperature of the raw material solution in Hayashi and Kato will vary based on ambient temperature, which varies from morning to night and season to season, even if the temperature of the reaction solution is controlled, the resulting crystal nuclei and particles will have various sizes and shapes.

Accordingly, the lack of temperature control of the raw material active solution in Hayashi and Kato makes the methods described in these references significantly different than in the present application, which will have a profound effect on the physical properties, including circularity and variation, of the resulting active material. It should be noted, additionally, that the production method of the active material described in the present application is merely one

means of obtaining the claimed active material. It is also possible to prepare the claimed active material having the same features by, for example, sizing a synthesized active material.

Furthermore, even in the active material of Example 1 of the present application, produced by controlling the temperature of the raw material solution but with a stirring rate only twice that of the Comparative Example, the number of particles having a circularity of not greater than 0.85 accounted for 10% of the total number of particles. Therefore, Applicants respectfully submit that it is highly unlikely that the active material particles of Hayashi or Kato, produced using a raw material solution of which the temperature was not controlled, have a circularity according to the present invention. Such an unlikelihood is not sufficient for a rejection based on inherency. Necessity is the standard required for an inherency rejection.

In conclusion, the claimed property that the number of particles having a circularity of not larger than 0.85 accounts for not more than 5% of the total particles in the active material is significant. When the circularity is controlled in this way, the resulting positive electrode material paste exhibits stable properties and the amounts of dispersion medium, thickener, etc. which must be added to the active material are reduced, resulting in an increased active material density in the electrode (page 16, lines 7-18).

Additionally, as described at page 15, line 22 to page 16, line 6, "when the number of particles having a circularity of not larger than 0.85 accounts for more than 5% of the number of total particles, the capacity of the positive electrode or the cycle life of the battery may be decreased." In other words, when the number of particles having a circularity of not larger than 0.85 accounts for 5% or less of the total number of particles contained in the active material, the positive electrode active capacity, as well as the cycle life of the battery, can be maintained at a high level. Specifically, as shown in Table 1 and described at page 38 of the application, batteries having higher capacity and longer cycle life are obtained by improving both the particle circularity and the particle size uniformity of the active material.

Since Hayashi and Kato do not teach or suggest the circularity of the positive electrode active material, one skilled in the art would not expect, based on either of these references, that control of particle circularity and particle size uniformity would have an effect on the stability or capacity of the positive electrode active material or the battery cycle life. Therefore, there would be no motivation based on either Hayashi or Kato to control the circularity at such a high level or to alter the reaction conditions to arrive at the claimed properties. In fact, it would not have been

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obvious to one skilled in the art at the time of the invention to specifically determine the circularity distribution needed in order to obtain a high capacity battery having excellent charge/discharge characteristics over a long period of time.

Applicants acknowledge that, once such a circularity distribution had been determined, it would have been only a matter of experimentation to determine the necessary conditions to obtain at such a distribution. However, since Hayashi and Kato do not recognize the parameter which needed optimization, nor the profound effect such a parameter would have on the resulting battery properties, one skilled in the art would not have been motivated to adjust the reaction conditions in order to arrive at the claimed positive electrode active material, and such an assumption is merely hindsight from the present invention.

For all of these reasons, Applicants respectfully submit that the pending claims are not anticipated by or rendered obvious over Hayashi or Kato, and reconsideration and withdrawal of the § 102(e) and § 103(a) rejections are respectfully requested.

In view of the above Remarks, Applicants respectfully submit that the pending claims are patentably distinct over the prior art of record and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,

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Attachments: Figures 1-4 from U.S. Patent No. 6,040,007